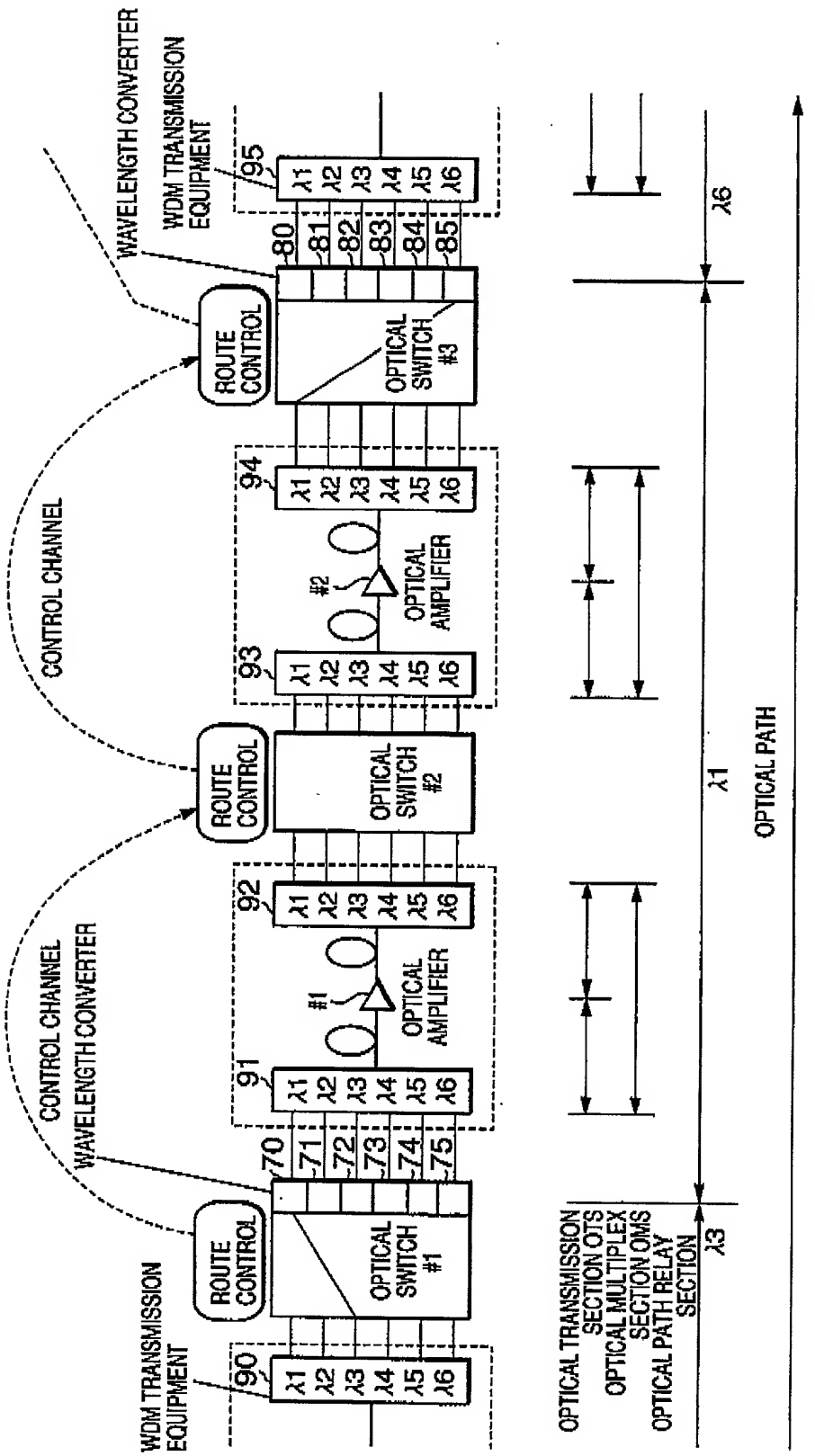

FIG. 1 PRIOR ART

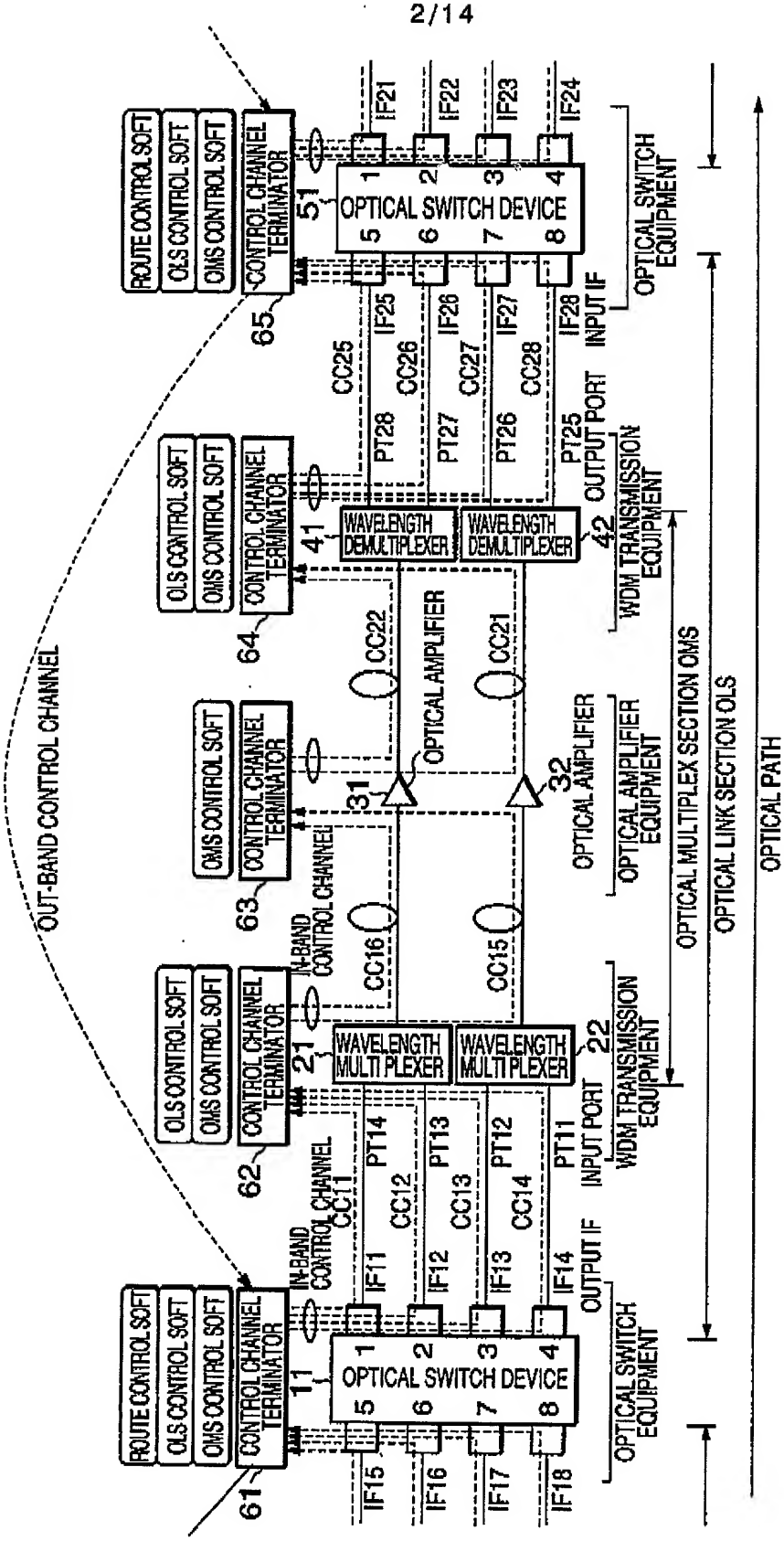
OUT-BAND CONTROL CHANNEL
ROUTE CONTROL SOFT
OLS CONTROL SOFT
OMS CONTROL SOFT
CONTROL CHANNEL TERMINATOR
OPTICAL SWITCH DEVICE
WAVELENGTH DEMULTIPLEXER
WAVELENGTH MULTI PLEXER
OPTICAL AMPLIFIER
IN-BAND CONTROL CHANNEL
INPUT IF
OUTPUT IF
INPUT PORT
OUTPUT PORT
OPTICAL SWITCH EQUIPMENT
WDM TRANSMISSION EQUIPMENT
OPTICAL AMPLIFIER EQUIPMENT
OPTICAL MULTIPLEX SECTION OMS
OPTICAL LINK SECTION OLS
OPTICAL PATH

FIG. 2

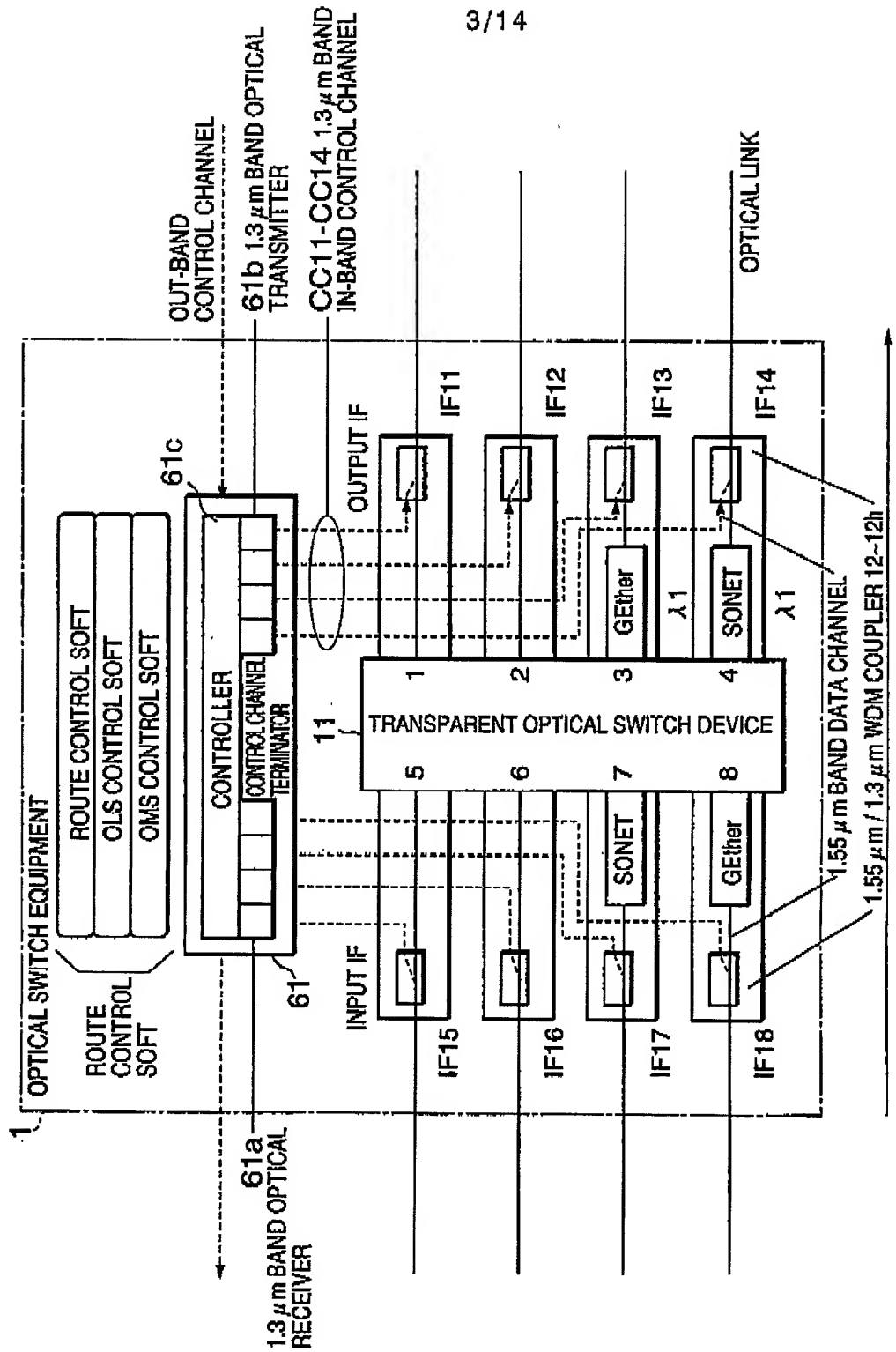
1
OPTICAL SWITCH EQUIPMENT
ROUTE CONTROL SOFT
OLS CONTROL SOFT
OMS CONTROL SOFT
ROUTE CONTROL SOFT
CONTROLLER
CONTROL CHANNEL TERMINATOR
61
61a
1.3 μm BAND OPTICAL RECEIVER
61b 1.3 μm BAND OPTICAL TRANSMITTER
61c
OUT-BAND CONTROL CHANNEL
CC11-CC14 1.3 μm BAND IN-BAND CONTROL CHANNEL
OUTPUT IF
INPUT IF
11
TRANSPARENT OPTICAL SWITCH DEVICE
IF11
IF12
IF13
IF14
IF15
IF16
IF17
IF18
GEther
SONET
λ1
OPTICAL LINK
1.55 μm BAND DATA CHANNEL
1.55 μm / 1.3 μm WDM COUPLER 12-12h
OPTICAL PATH

FIG. 3

02- 1-23;20:36 ;柳藩・池田特許事務所 Dickstein ;8133503025O # 82/ 92

ATTRIBUTE ITEMS	IF11	IF12	IF13	IF14
OUTPUT OPTICAL SWITCH NO.	1	1	1	1
OUTPUT IF NO.	1	2	3	4
WAVELENGTH	ARBITRARY	ARBITRARY	λ1	λ1
SIGNAL RATE	ARBITRARY	ARBITRARY	1Gbit/s	2.5Gbit/s
SIGNAL FORMAT	ARBITRARY	ARBITRARY	GEther	SONET

FIG. 4A

ATTRIBUTE ITEMS	IF25	IF26	IF27	IF28
INPUT OPTICAL SWITCH NO.	5	5	5	5
INPUT IF NO.	5	5	7	8
WAVELENGTH	ARBITRARY	ARBITRARY	ARBITRARY	ARBITRARY
SIGNAL RATE	ARBITRARY	ARBITRARY	2.5Gbit/s	1Gbit/s
SIGNAL FORMAT	ARBITRARY	ARBITRARY	SONET	GEther

FIG. 4B

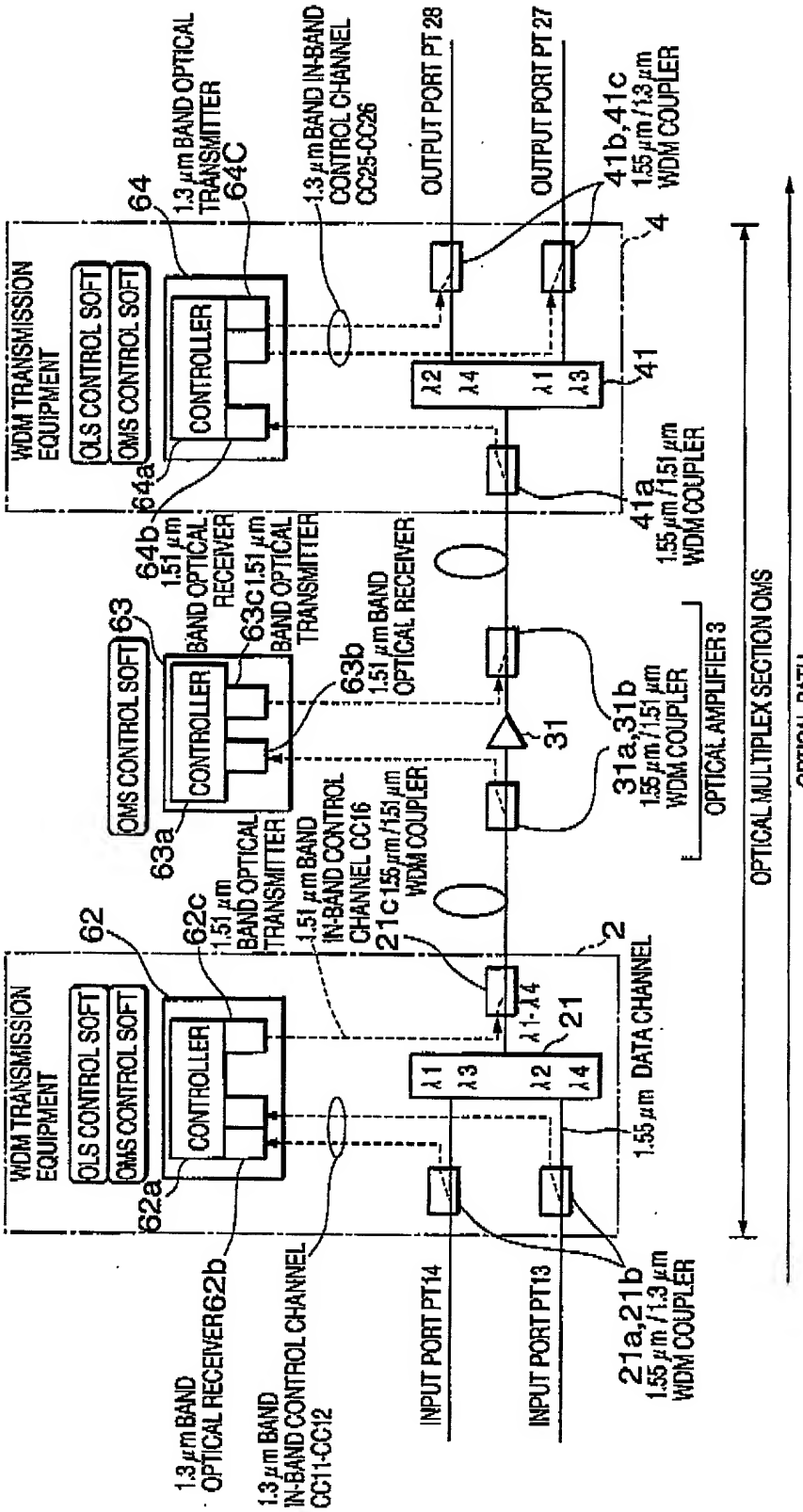
WDM TRANSMISSION EQUIPMENT
OLS CONTROL SOFT
OMS CONTROL SOFT
CONTROLLER
64
64a
64C
1.3 μm BAND OPTICAL TRANSMITTER
1.3 μm BAND IN-BAND CONTROL CHANNEL CC25-CC26
OUTPUT PORT PT 28
OUTPUT PORT PT 27
41b,41c
1.55 μm/1.3 μm WDM COUPLER
4
41
λ2 λ4 λ1 λ3
41a
1.55 μm/1.51 μm WDM COUPLER
64b
1.51 μm BAND OPTICAL RECEIVER
63c 1.51 μm BAND OPTICAL TRANSMITTER
63
63a
63b
1.51 μm BAND OPTICAL RECEIVER
31
31a,31b
1.55 μm/1.51 μm WDM COUPLER
OPTICAL AMPLIFIER 3
62
62a
62c
1.51 μm BAND OPTICAL TRANSMITTER
1.51 μm BAND IN-BAND CONTROL CHANNEL CC16
21c 1.55 μm/1.51 μm WDM COUPLER
2
λ1-λ4
21
λ1 λ3 λ2 λ4
1.55 μm DATA CHANNEL
1.3 μm BAND OPTICAL RECEIVER 62b
1.3 μm BAND IN-BAND CONTROL CHANNEL CC11-CC12
INPUT PORT PT14
INPUT PORT PT13
21a,21b
1.55 μm/1.3 μm WDM COUPLER
OPTICAL MULTIPLEX SECTION OMS
OPTICAL PATH

FIG. 5

20:13:10 '05 SEP 30 07:37

ATTRIBUTE ITEMS	PT11	PT12	PT13	PT14
WAVELENGTH	λ2	λ1	λ2, λ4	λ1, λ3
SIGNAL RATE	≤40 Gbit/s	≤40 Gbit/s	≤10 Gbit/s	≤10 Gbit/s
SIGNAL FORMAT	ARBITRARY	ARBITRARY	ARBITRARY	ARBITRARY
OMS GROUP NO.	2	2	1	1

FIG. 6A

ATTRIBUTE ITEMS	PT25	PT26	PT27	PT28
WAVELENGTH	λ1	λ2	λ1, λ3	λ2, λ4
SIGNAL RATE	≤40 Gbit/s	≤40 Gbit/s	≤10 Gbit/s	≤10 Gbit/s
SIGNAL FORMAT	ARBITRARY	ARBITRARY	ARBITRARY	ARBITRARY
OMS GROUP NO.	2	2	1	1

FIG. 6B

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FIG. 7A

CC11
IF11→PT14
ATTRIBUTE ITEMS

OUTPUT OPTICAL SWITCH NO.	1
OUTPUT IF NO.	1
WAVELENGTH	ARBITRARY
SIGNAL RATE	ARBITRARY
SIGNAL FORMAT	ARBITRARY

FIG. 7B

CC12
IF12→PT13
ATTRIBUTE ITEMS

OUTPUT OPTICAL SWITCH NO.	1
OUTPUT IF NO.	2
WAVELENGTH	ARBITRARY
SIGNAL RATE	ARBITRARY
SIGNAL FORMAT	ARBITRARY

FIG. 7C

CC13
IF13→PT12
ATTRIBUTE ITEMS

OUTPUT OPTICAL SWITCH NO.	1
OUTPUT IF NO.	3
WAVELENGTH	λ1
SIGNAL RATE	1 Gbit/s
SIGNAL FORMAT	GEther

FIG. 7D

CC14
IF14→PT11
ATTRIBUTE ITEMS

OUTPUT OPTICAL SWITCH NO.	1
OUTPUT IF NO.	4
WAVELENGTH	λ1
SIGNAL RATE	2.5 Gbit/s
SIGNAL FORMAT	SONET

CC16,22
PT14, 13→PT27,28
ATTRIBUTE ITEMS

OUTPUT OPTICAL SWITCH NO.	1	1
OUTPUT IF NO.	1	2
WAVELENGTH	λ1, λ3	λ2, λ4
SIGNAL RATE	≤10 Gbit/s	≤10 Gbit/s
SIGNAL FORMAT	ARBITRARY	ARBITRARY
OMS GROUP NO.	1	1

FIG. 8A

CC15,21
PT12, 11→PT25,26
ATTRIBUTE ITEMS

OUTPUT OPTICAL SWITCH NO.	1	1
OUTPUT IF NO.	3	4
WAVELENGTH	λ1	ERROR
SIGNAL RATE	1 Gbit/s	2.5Gbit/s
SIGNAL FORMAT	GEther	SONET
OMS GROUP NO.	2	2

FIG. 8B

FIG. 9A

CC26
PT27→IF26
ATTRIBUTE ITEMS

OUTPUT OPTICAL SWITCH NO.	1
OUTPUT IF NO.	1
WAVELENGTH	λ1, λ3
SIGNAL RATE	≦10Gbit/s
SIGNAL FORMAT	ARBITRARY
OMS GROUP NO.	1

FIG. 9B

CC25
PT28→IF25
ATTRIBUTE ITEMS

OUTPUT OPTICAL SWITCH NO.	1
OUTPUT IF NO.	2
WAVELENGTH	λ2, λ4
SIGNAL RATE	≦10Gbit/s
SIGNAL FORMAT	ARBITRARY
OMS GROUP NO.	1

FIG. 9C

CC28
PT25→IF28
ATTRIBUTE ITEMS

OUTPUT OPTICAL SWITCH NO.	1
OUTPUT IF NO.	3
WAVELENGTH	λ1
SIGNAL RATE	≦1 Gbit/s
SIGNAL FORMAT	GEther
OMS GROUP NO.	2

FIG. 9D

CC27
PT26→IF27
ATTRIBUTE ITEMS

OUTPUT OPTICAL SWITCH NO.	1
OUTPUT IF NO.	4
WAVELENGTH	ERROR
SIGNAL RATE	2.5Gbit/s
SIGNAL FORMAT	SONET

ATTRIBUTE ITEMS

OUTPUT OPTICAL SWITCH NO.	1	1	1	1
OUTPUT IF NO.	1	2	3	4
WAVELENGTH	$\lambda 1, \lambda 3$	$\lambda 2, \lambda 4$	$\lambda 1$	ERROR
SIGNAL RATE	$\leq$10 Gbit/s	$\leq$10 Gbit/s	10 Gbit/s	2.5 Gbit/s
SIGNAL FORMAT	ARBITRARY	ARBITRARY	GEther	SONET
OMS GROUP NO.	1	1	2	2
INPUT OPTICAL SWITCH NO.	5	5	5	5
INPUT IF NO.	6	5	8	7

FIG. 10

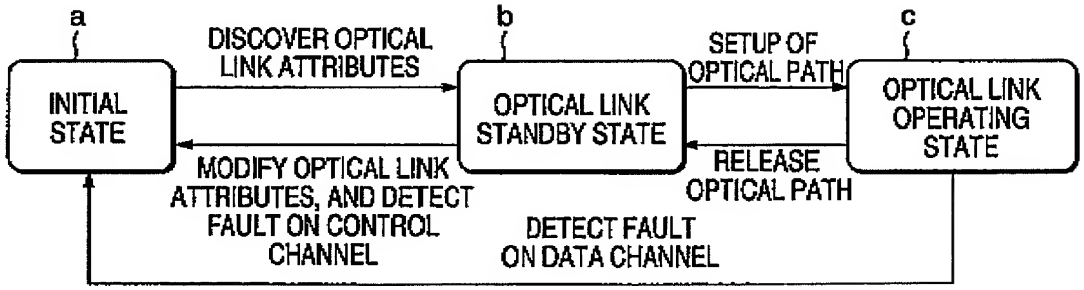

FIG. 11

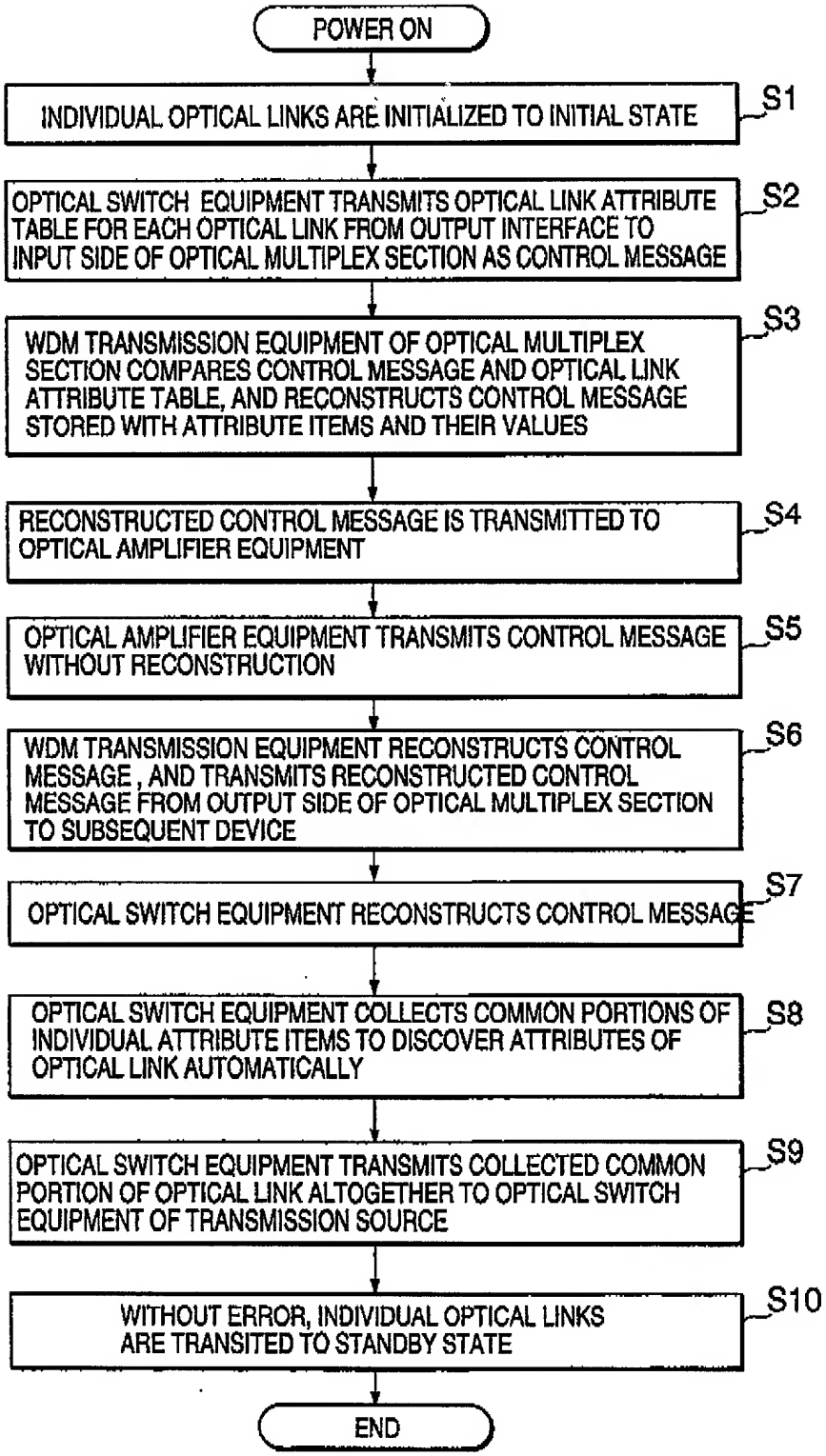
POWER ON
INDIVIDUAL OPTICAL LINKS ARE INITIALIZED TO INITIAL STATE
S1
OPTICAL SWITCH EQUIPMENT TRANSMITS OPTICAL LINK ATTRIBUTE TABLE FOR EACH OPTICAL LINK FROM OUTPUT INTERFACE TO INPUT SIDE OF OPTICAL MULTIPLEX SECTION AS CONTROL MESSAGE
S2
WDM TRANSMISSION EQUIPMENT OF OPTICAL MULTIPLEX SECTION COMPARES CONTROL MESSAGE AND OPTICAL LINK ATTRIBUTE TABLE, AND RECONSTRUCTS CONTROL MESSAGE STORED WITH ATTRIBUTE ITEMS AND THEIR VALUES
S3
RECONSTRUCTED CONTROL MESSAGE IS TRANSMITTED TO OPTICAL AMPLIFIER EQUIPMENT
S4
OPTICAL AMPLIFIER EQUIPMENT TRANSMITS CONTROL MESSAGE WITHOUT RECONSTRUCTION
S5
WDM TRANSMISSION EQUIPMENT RECONSTRUCTS CONTROL MESSAGE , AND TRANSMITS RECONSTRUCTED CONTROL MESSAGE FROM OUTPUT SIDE OF OPTICAL MULTIPLEX SECTION TO SUBSEQUENT DEVICE
S6
OPTICAL SWITCH EQUIPMENT RECONSTRUCTS CONTROL MESSAGE
S7
OPTICAL SWITCH EQUIPMENT COLLECTS COMMON PORTIONS OF INDIVIDUAL ATTRIBUTE ITEMS TO DISCOVER ATTRIBUTES OF OPTICAL LINK AUTOMATICALLY
S8
OPTICAL SWITCH EQUIPMENT TRANSMITS COLLECTED COMMON PORTION OF OPTICAL LINK ALTOGETHER TO OPTICAL SWITCH EQUIPMENT OF TRANSMISSION SOURCE
S9
WITHOUT ERROR, INDIVIDUAL OPTICAL LINKS ARE TRANSITED TO STANDBY STATE
S10
END

FIG. 12

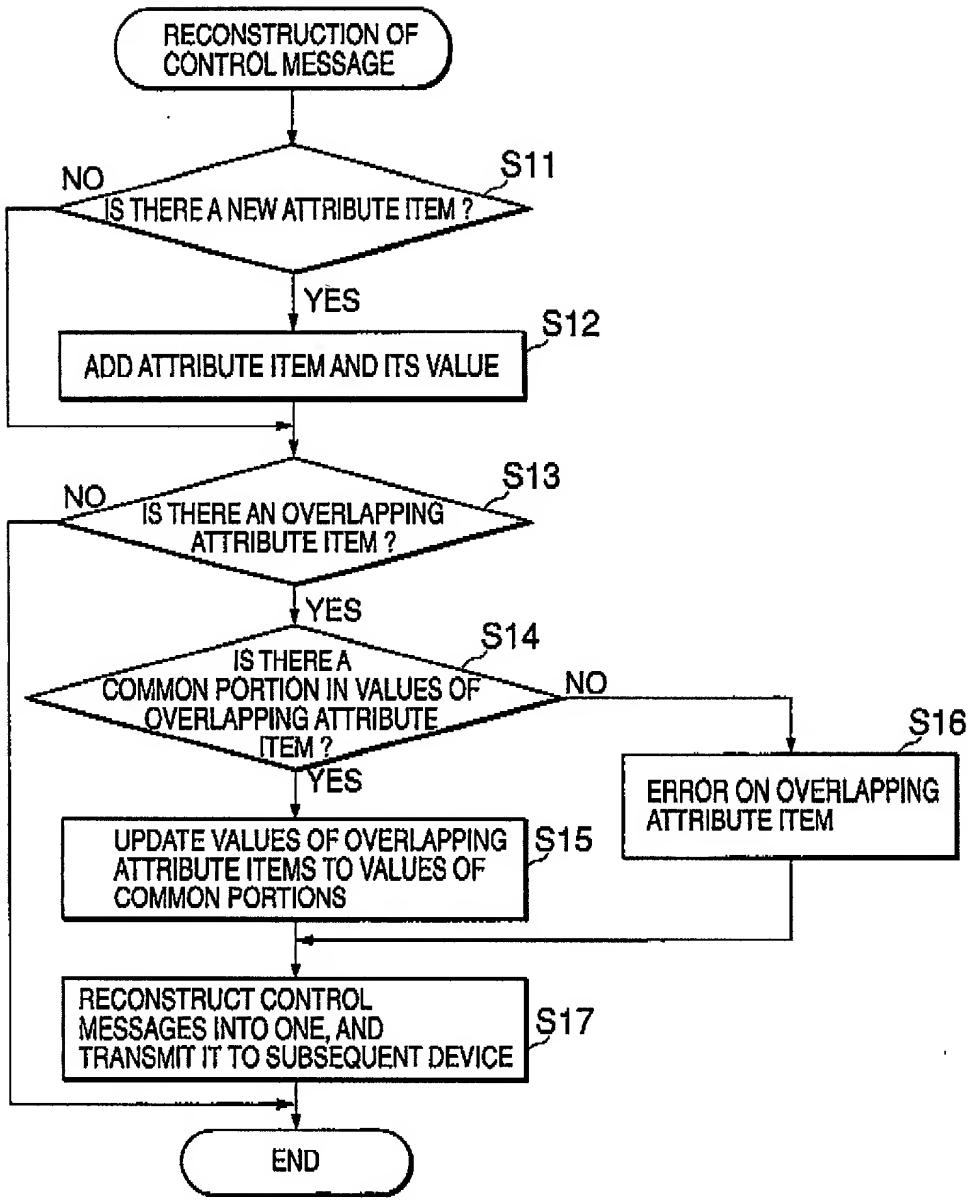
RECONSTRUCTION OF CONTROL MESSAGE
S11
NO
IS THERE A NEW ATTRIBUTE ITEM ?
YES
S12
ADD ATTRIBUTE ITEM AND ITS VALUE
S13
NO
IS THERE AN OVERLAPPING ATTRIBUTE ITEM ?
YES
S14
IS THERE A COMMON PORTION IN VALUES OF OVERLAPPING ATTRIBUTE ITEM ?
NO
S16
ERROR ON OVERLAPPING ATTRIBUTE ITEM
YES
S15
UPDATE VALUES OF OVERLAPPING ATTRIBUTE ITEMS TO VALUES OF COMMON PORTIONS
S17
RECONSTRUCT CONTROL MESSAGES INTO ONE, AND TRANSMIT IT TO SUBSEQUENT DEVICE
END

FIG. 13

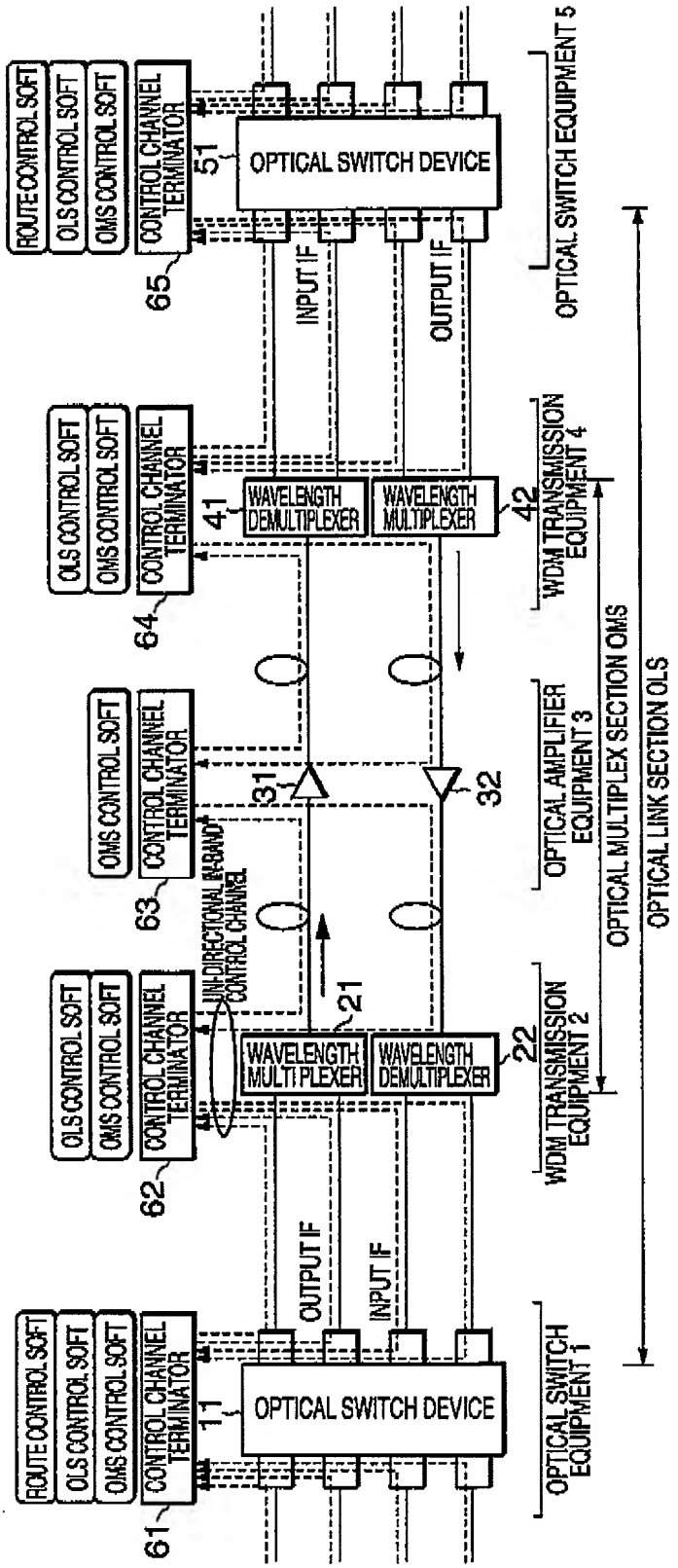
ROUTE CONTROL SOFT
OLS CONTROL SOFT
OMS CONTROL SOFT
CONTROL CHANNEL TERMINATOR
61
OPTICAL SWITCH DEVICE
11
OUTPUT IF
INPUT IF
OPTICAL SWITCH EQUIPMENT 1
OLS CONTROL SOFT
OMS CONTROL SOFT
CONTROL CHANNEL TERMINATOR
62
WAVELENGTH MULTIPLEXER
WAVELENGTH DEMULTIPLEXER
22
WDM TRANSMISSION EQUIPMENT 2
OMS CONTROL SOFT
CONTROL CHANNEL TERMINATOR
63
OPTICAL AMPLIFIER EQUIPMENT 3
OLS CONTROL SOFT
OMS CONTROL SOFT
CONTROL CHANNEL TERMINATOR
64
WAVELENGTH DEMULTIPLEXER
WAVELENGTH MULTIPLEXER
42
WDM TRANSMISSION EQUIPMENT 4
ROUTE CONTROL SOFT
OLS CONTROL SOFT
OMS CONTROL SOFT
CONTROL CHANNEL TERMINATOR
65
OPTICAL SWITCH DEVICE
51
INPUT IF
OUTPUT IF
OPTICAL SWITCH EQUIPMENT 5
21
31
32
1IN-DIRECTIONAL 1-BAND CONTROL CHANNEL
OPTICAL MULTIPLEX SECTION OMS
OPTICAL LINK SECTION OLS

FIG. 14

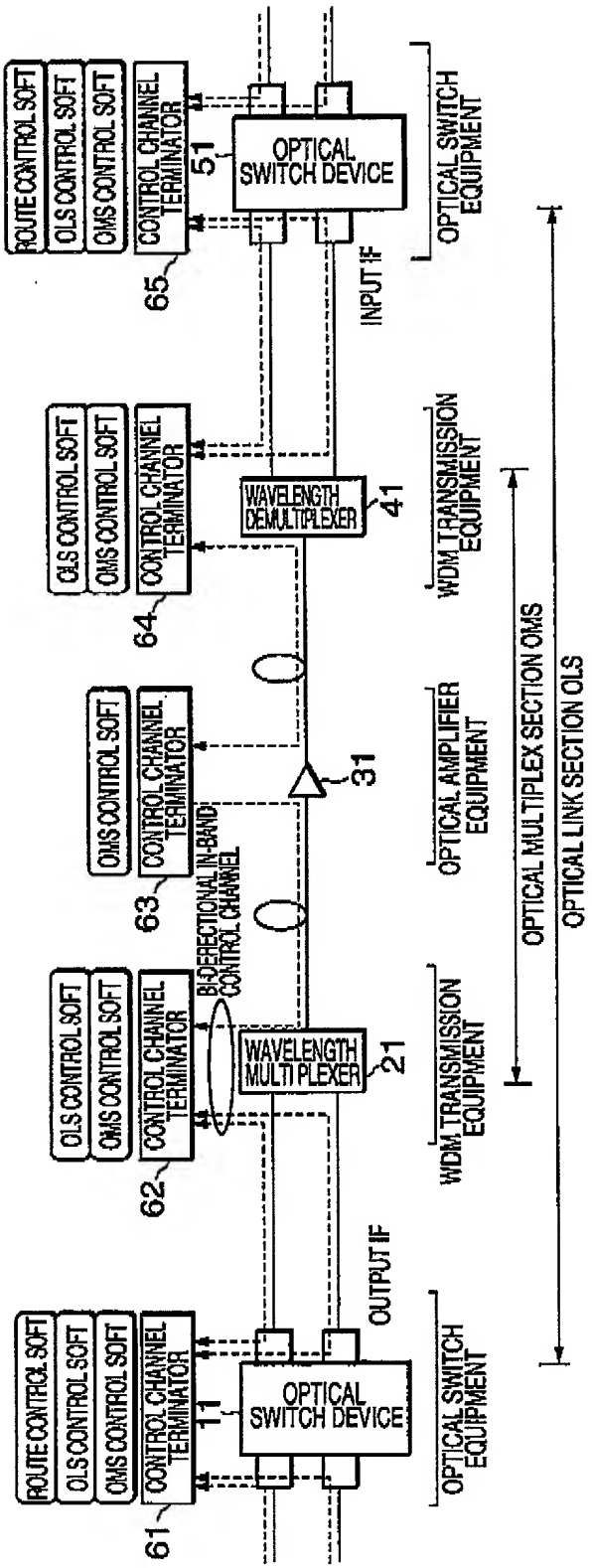
ROUTE CONTROL SOFT
OLS CONTROL SOFT
OMS CONTROL SOFT
CONTROL CHANNEL TERMINATOR
61
OPTICAL SWITCH DEVICE
11
OUTPUT IF
OPTICAL SWITCH EQUIPMENT
WAVELENGTH MULTI PLEXER
21
WDM TRANSMISSION EQUIPMENT
OLS CONTROL SOFT
OMS CONTROL SOFT
CONTROL CHANNEL TERMINATOR
62
BI-DERECTIONAL IN-BAND CONTROL CHANNEL
OMS CONTROL SOFT
CONTROL CHANNEL TERMINATOR
63
31
OPTICAL AMPLIFIER EQUIPMENT
OLS CONTROL SOFT
OMS CONTROL SOFT
CONTROL CHANNEL TERMINATOR
64
WAVELENGTH DEMULTIPLEXER
41
WDM TRANSMISSION EQUIPMENT
ROUTE CONTROL SOFT
OLS CONTROL SOFT
OMS CONTROL SOFT
CONTROL CHANNEL TERMINATOR
65
OPTICAL SWITCH DEVICE
51
INPUT IF
OPTICAL SWITCH EQUIPMENT
OPTICAL MULTIPLEX SECTION OMS
OPTICAL LINK SECTION OLS

FIG. 15